(12) UK Patent Application (19) GB (11) 2 323 236 (13) A

(43) Date of A Publication 16.09.1998

(21) Application No 9804927.3

(22) Date of Filing 10.03.1998

(30) Priority Data
(31) 19710727 (32) 14.03.1997 (33) DE

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(51) INT CL[6]
H04N 7/18 , G08B 15/00

(52) UK CL (Edition P)
H4F FAAE FD24

(56) Documents Cited
GB 2306061 A GB 2289144 A GB 2235848 A
EP 0714081 A1 WO 97/08896 A1

(58) Field of Search
UK CL (Edition P) H4F FAAE
INT CL[6] G08B 13/196 15/00 , H04N 7/18

(54) Abstract Title
Video surveillance system

(57) A monitoring apparatus comprises, in a first embodiment, a plurality of cameras 3, 3a, 3b, each of which is associated with a predetermined solid angle within a predetermined monitored space, at least one monitor 4 to which a selected one of the images delivered by the cameras is switched, and a scanning device 1 for scanning the predetermined monitored space: On the appearance of an object 6 in this monitored space, the scanning device 1 transmits output signals which reproduce a position of the object 6 in the monitored space. A camera control 2 automatically receives the output signals of the scanning device and switches the camera 3 having a solid angle in which the object 6 is located, onto the at least one monitor 4. In a second embodiment, a monitoring apparatus for the monitoring of a predetermined monitored space uses a camera 3, of which the spatial alignment is adjustable, and a monitor 4, onto which the image delivered by the camera is switched. The monitoring apparatus also includes a scanning device 1 for the scanning of the predetermined monitored space. On the appearance of an object 6 in this monitored space, the scanning device 1 transmits output signals which reproduce a position of the object 6 in the monitored space. A camera control 2 controls the spatial alignment of the camera 3, on the basis of the output signals of the scanning device, for the detection of the object 6.

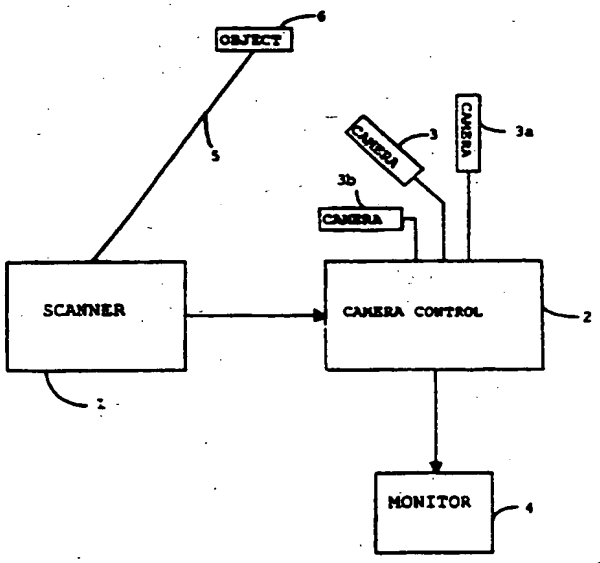

Fig. 2

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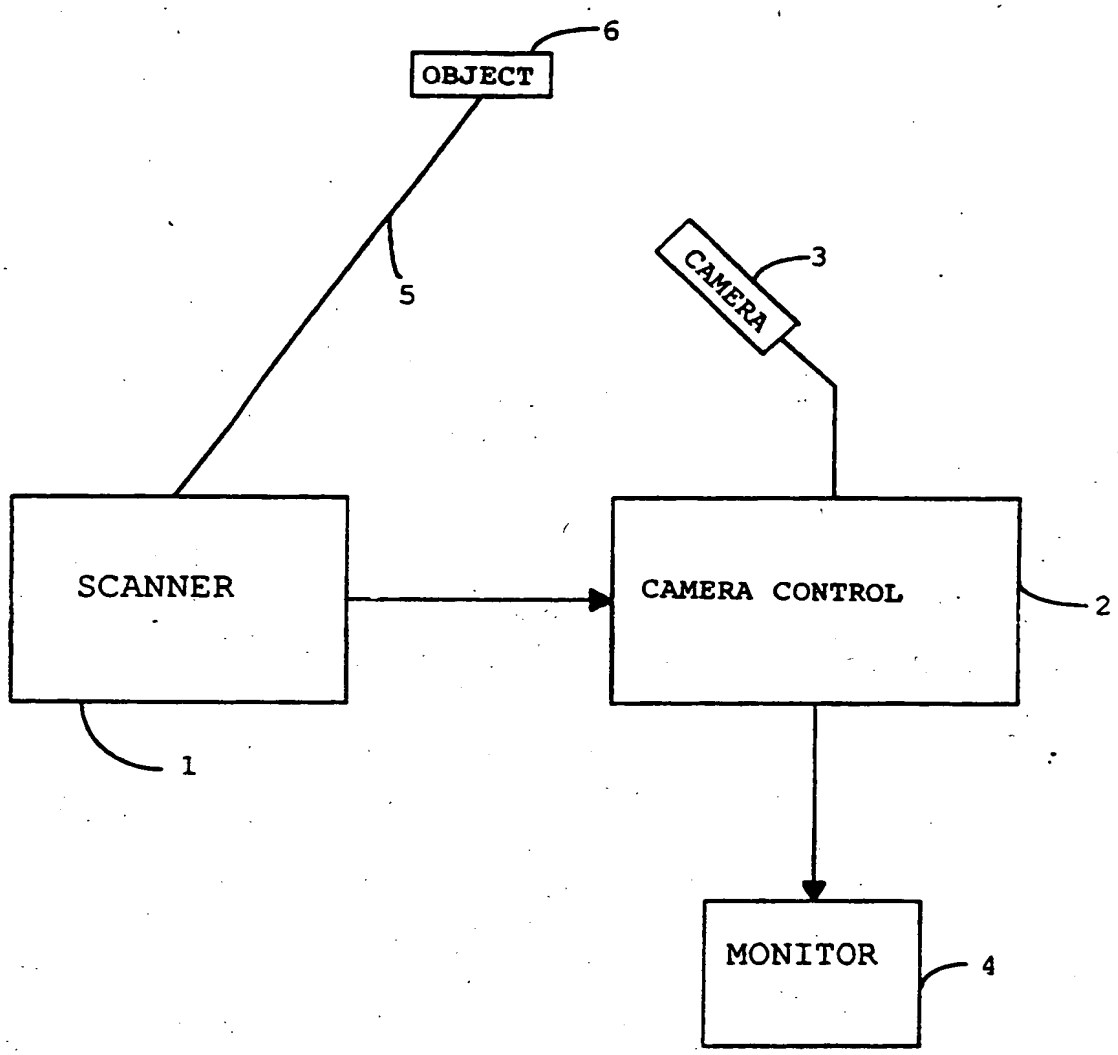

Fig. 1

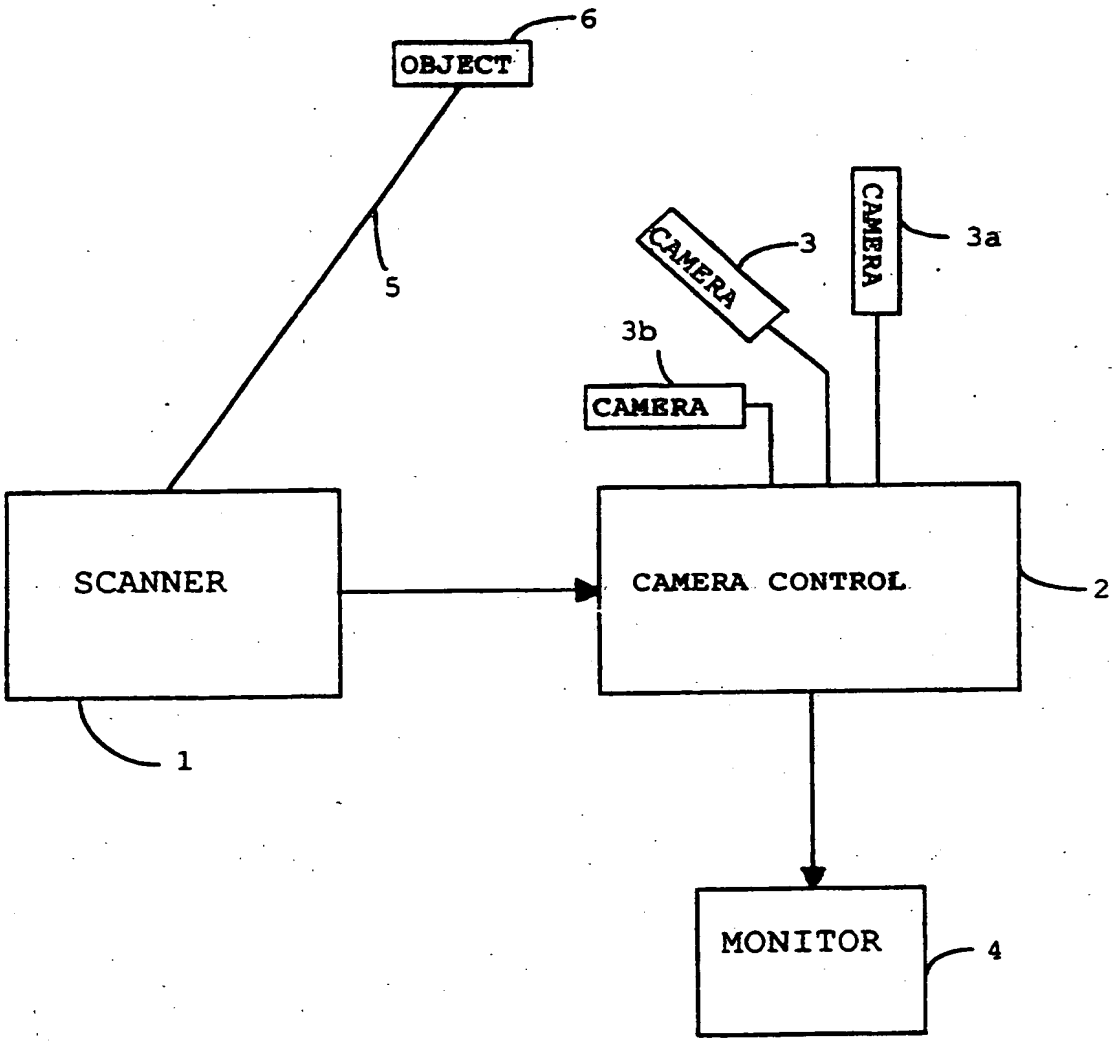
6
OBJECT
5
CAMERA
3
CAMERA
3a
3b
CAMERA
SCANNER
CAMERA CONTROL
2
1
MONITOR
4

Fig. 2

MONITORING APPARATUS

The present invention relates to a monitoring apparatus comprising a plurality of cameras, each of which is associated with a predetermined solid angle within a predetermined monitored space, and at least one monitor to which a selected one of the images delivered by the cameras is switched. The invention likewise relates to a monitoring apparatus for the monitoring of a predetermined monitored space using a camera, of which the spatial alignment is adjustable, and a monitor, onto which the picture delivered by the camera is switched.

In known monitoring apparatus with a plurality of cameras a considerably smaller number of monitors are usually available for this plurality. A changeover of the monitor from one camera to another camera is therefore necessary in order to guarantee a monitoring procedure which is as free of gaps as possible timewise. This was hitherto either effected manually, by monitoring personnel entrusted with the observation of the monitors, or a group of cameras was automatically switched to a monitor associated with it in turn.

Likewise known is monitoring apparatus with only one camera. With such monitoring apparatus the problem frequently exists that the solid angle of the camera is too small to enable monitoring of the entire monitored space. Accordingly, this camera is normally made adjustable with respect to its spatial alignment and is pivoted periodically in a suitable manner to cover the entire monitored space.

In such known monitoring apparatus the possibility exists that an object, in particular an intruding person, can appear in the monitored space

without being visible on a monitor or being seen by the monitoring personnel, within a time period in which, with a plurality of cameras, one camera is not switched to a monitor, or, when using a single, pivotable camera, when the actual spatial alignment within the range of pivoting is unsuitable.

An object of the invention is thus to avoid, as far as possible, an object appearing in the predetermined monitored space without being noticed by the monitoring personnel.

This object is satisfied in the monitoring apparatus of the initially named kind with a plurality of cameras by a scanning device for scanning the predetermined monitored space and, on the appearance of an object in this monitored space, for transmitting output signals which reproduce a position of the object in the monitored space, and by a camera control for the automatic reception of the output signals of the scanning device and, starting from these output signals, for switching the image from the camera having a solid angle of which the object is located onto the at least one monitor.

Thus, in accordance with the invention, the scanning device detects an object which appears in the predetermined monitored space, which is for example a garden of a house, a section of terrain, or a room within a building, and then transmits output signals which reproduce the position of the object in the monitored space, or from which this position can at least be calculated. The camera control determines, as a result of the output signals delivered by the scanning device on the position of the object in the monitored space, that camera of which the predetermined solid angle includes this position in the monitored space. Moreover, it automati-

cally switches this camera, responding to the output signals of the scanning device, onto at least one monitor.

In this manner, in contrast to known monitoring apparatus, it is ensured that, when an object appears in the monitored space, for example an intruding person, the picture delivered by the camera having a solid angle in which the object is located is immediately seen on a monitor. This camera can run continually or can first be switched on when the scanning device detects an object in the monitored space. In particular it is not necessary for the operating personnel to become active in order to observe the object.

The appearance of an object can be detected by the scanning device, with the output signals, for example, only being transmitted for the control of the camera when an object is present in the monitored space. In just the same way the scanning device can also continually transmit output signals to the camera control, which are then checked by the latter for the appearance of an object in the monitored space.

The spatial alignment and image forming characteristics of each camera, in particular the focusing, image section and zoom, are preferably adjustable, so that the object detected can be fully shown in the desired picture or image size on the monitor. The camera control then controls the camera having a solid angle in which the object is located, on the basis of the output signals of the scanning device, so that its spatial alignment and image forming characteristics are optimised with respect to the image.

Since the position of the object in the monitored space is known as a result of the scanning device, and since the space monitoring positions of all cameras, and in particular of their optical axes, are self-evidently also known in a reference coordinate system, it is possible to determine a posi-

tion relative to the object of the optical axis of the camera having a solid angle, or field of view, in which the object is located. Thus, on the one hand, the spatial alignment of this camera, which is for example pivotally mounted on a stand by means of one or two positioning motors with respect to one or two rotational degrees of freedom, with the angular position of the camera being measured with respect to a starting position using angle sensors, can be set in the direction towards the object. On the other hand, the image forming characteristics of this camera, in particular the position of its focal plane, can be set as a result of the spacing of the camera from the object, as determined by means of the scanning device, for example by displacement of an image forming optical system of the camera along its optical axis.

This embodiment of the invention offers the advantage that the object can be very clearly considered by the monitoring personnel because the pictures delivered by the camera have a very good quality. In contrast, in the known monitoring apparatus, it is necessary either for the cameras to operate in a self focusing manner, with it, however, not being possible for them to treat the distance to the object, i.e. the image distance, as known, or the images of the cameras must be manually adjusted so that they are sharp.

A plurality of monitors is preferably provided, with the camera control switching, on the appearance of a plurality of objects, those cameras having a solid angle in which at least one of these objects is located onto one of these monitors in each case.

In this manner it is possible for the monitoring personnel to simultaneously perceive a plurality of objects appearing at different solid angles.

In a monitoring apparatus of the above named kind with only one camera, the above named object is satisfied by a scanning device for the scanning of a predetermined monitored space and, on the appearance of an object in this monitored space, for the transmission of output signals which reproduce a position of the object in the monitored space, and by a camera control for the control of the spatial alignment of the camera, for the detection of the object, starting from the output signals of the scanning device.

In this manner it is ensured, even with a monitoring apparatus with only one camera, that an object appearing in the monitored space does not remain unnoticed.

The camera is preferably adjustable with respect to its image forming characteristics and the camera control controls the image forming characteristics of the camera, in particular the focusing, starting from the output signals of the scanning device, in order to optimise the image of the object. For both the above named types of monitoring apparatus, the scanning device is preferably a scanner, which scans the predetermined monitored space with periodic sequential scanning procedures using pulses of laser light appearing on a periodically moved beam axis, and which detects reflected laser light by means of an optical detection device.

The scanner used in accordance with the invention permits a contact-free periodic scanning of the monitored space. The beam axis can, for example, be moved by providing a rotating, polygonal mirror wheel. With respect to the characteristics of the scanner, in particular its spatial resolution, reference is made to the subject of the German patent application P 43 40 756.0.

When the scanner determines the position of the object in the monitored space by determining the distance between the scanner and the object, and also by determining the spatial direction from the scanner to the object in relation to a reference coordinate system, then the position of the object in the monitored space can be determined particularly easily. In this case a spherical coordinate system with the known variables r, θ and φ with its origin at a position of the scanning device offers itself as the reference coordinate system, with r being the same as the distance between the scanner and the object.

The distance between the scanner and the object can preferably be determined by a transit time measurement of the light pulse.

In contrast, the spatial direction from the scanner to the object is preferably determined by angle sensors, which measure the angle of the beam axis in relation to the reference coordinate system.

For the detection of an appearance of an object, the camera control and/or the scanner preferably includes a storage device in which at least two scanning angle-distance data sets for scanning procedures can be stored and a comparison device which compares the data sets in the storage device with one another. On detecting a difference among these data sets with respect to the measured distance for any particular scanning angle, the appearance of an object is determined. Output signals, which reproduce the position of the object in the monitored space in the reference coordinate system, are then used for the control of the camera and/or of the monitor.

The storage and the comparison of the data sets is, for example, effected by a microprocessor.

The storage device can in particular contain a scanning angle/spacing data set for a reference scan of the monitored space without an appearing object. The comparison device then compares the data set for each new scan with the data set for the reference scan. This is particularly advantageous when objects exist which are continually present in the monitored space and which reflect the laser beam, i.e. when the appearance of an object is not simply concluded from the fact that reflected light is detected at all.

Moreover, it is also possible for the beam axis to be varied only within one horizontal plane with respect to its setting. For example, it can be sufficient when monitoring a section of terrain, or also a room, to use the laser beams only at a suitable distance and parallel to the floor. In this case, when using a spherical coordinate system, no change of the angle θ occurs, so that only the stored values for the angle φ and the range remain (line scanner).

The cameras are preferably video cameras.

The invention will be described in more detail in the following with respect to the drawings, which schematically illustrate preferred embodiments of the invention. There are shown:

Fig. 1 a monitoring apparatus in accordance with the invention with one camera, and

Fig. 2 a monitoring apparatus in accordance with the invention with a plurality of cameras.

The monitoring apparatus shown in Fig. 1 includes a scanner 1 and a camera control 2. Furthermore, the monitoring apparatus has a camera 3 and a monitor 4.

The scanner 1 includes a laser which, at regular intervals, transmits a pulsed laser beam within a horizontal plane (in Fig. 1 the plane of the drawing) which lies in a monitored space, with a beam axis 5 of the laser beam being continually varied so that the horizontal plane is reliably covered. The position of the beam axis 5 in the monitored space is determined by an angle sensor provided in the scanner 1.

The positions in the monitored space of the scanner 1, of the camera 3, and also of their optical axes are known. In particular the positions in the monitored space are determined by coordinates ϕ and r of a spherical coordinate system, with its origin at the position of the scanner 1 in the monitored space. The position of the optical axis of the camera 3 is determined by a further angle relative to the starting position of this optical axis.

When the laser beam strikes an object 6, the laser light is scattered at the object 6. A part of the laser light is reflected back to the scanner 1 and, for example, detected with the aid of a photoreceiver. The transit time of the reflected laser light, and thus the distance d of the object 6 from the scanner 1, is determined by the difference between the point in time of the detection of this laser light and the point in time at which the laser light left the scanner 1.

The camera control 2 has a storage device, in which a reference data set comprising scanning angle/range values for each position of the beam axis 5 are stored. If a scanning angle/range value which differs from the reference data set is measured for a specific position of the beam axis 5, then the appearance of the object 6 is determined and the actual coordinate values for the scanning angle ϕ of the beam axis 5 and the distance d of the object 6 from the scanner 1 are conveyed to the camera control 2.

On the appearance of the object 6 the scanner 1 conveys the scanning angle/range value found for the object 6 to the camera control 2, which then correspondingly aligns, and in particular pivots, the camera 3 to embrace the object 6. Furthermore, the camera control 2 controls, as a result of the distance which can be found between the camera 3 and the object 6, the image forming characteristics of the camera, such as the image section (or picture detail) and zoom for the ideal representation of the object 6 on the monitor 4.

Fig. 2 shows a monitoring apparatus in accordance with the invention with a plurality of cameras. In Fig. 2, the parts already shown in Fig. 1 are designated with the same reference numerals.

The monitoring apparatus includes a plurality of cameras and monitors, of which, for the sake of simplification, three pivotable cameras 3, 3a, 3b and the monitor 4 are shown in the example illustrated in Fig. 2. The manners of operation of the scanner 1 and of the camera 3, 3a and 3b are the same as described previously.

The camera control 2, which is connected to all the cameras, determines, as a result of the coordinate values delivered by the scanner 1, the camera having a solid angle of field of view in which these coordinate values lie, in the example of Fig. 2 the camera 3. The image delivered by the camera 3 is then switched to the monitor 4, which is located at a monitoring post.

Moreover, the camera control 2 uses the transmitted coordinate values to determine a range between the object 6 and the camera 3. In this manner the position of the ideal focal plane for the camera 3 for the portrayal of the object is found and the sharp adjustment of its image is made possible.

Furthermore, the cameral control 2 likewise causes a pivotal movement of the optical axis of the camera 3, in order to align this camera 3 onto the object 6.

PATENT CLAIMS

1. Monitoring apparatus comprising a plurality of cameras (3, 3a, 3b), each of which is associated with a predetermined solid angle within a predetermined monitored space, and at least one monitor (4) to which a selected one of the images delivered by the cameras is switched, characterized by a scanning device (1) for scanning the predetermined monitored space and, on the appearance of an object (6) in this monitored space, for transmitting output signals which reproduce a position of the object (6) in the monitoring space, and by a camera control (2) for the automatic reception of the output signals of the scanning device and, starting from these output signals, for switching the image from the camera (3) having a solid angle in which the object (6) is located onto the at least one monitor (4).

2. Monitoring apparatus in accordance with claim 1, characterized in that the spatial alignment and image forming characteristics of each camera (3, 3a, 3b) are adjustable and in that the camera control (2) controls, on the basis of the output signals of the scanning device, the spatial alignment and/or the image forming characteristics, in particular the focusing, image section or zoom of the respective camera (3) having a the solid angle in which the object (6) is located for the optimisation of the image of the object (6).

3. Monitoring apparatus in accordance with one of the claims 1 or 2, characterized in that a plurality of monitors are provided and the camera control (2) switches, on the appearance of further objects,

each of those cameras in the solid angle of which at least one of these objects is located onto one of these monitors in each case.

4. Monitoring apparatus for the monitoring of a predetermined monitored space using a camera (3), of which the spatial alignment is adjustable, and a monitor (4), onto which the image delivered by the camera is switched, characterised by a scanning device (1) for the scanning of the predetermined monitored space and, on the appearance of an object (6) in this monitored space, for the transmission of output signals which reproduce a position of the object (6) in the monitored space, and by a camera control (2) for the control of the spatial alignment of the camera (3), starting from the output signals of the scanning device, for the detection of the object (6).

5. Monitoring apparatus in accordance with claim 4, characterized in that the camera (3) is adjustable with respect to its image forming characteristics, and in that the camera control (2) controls the image forming characteristics of the camera, in particular the focusing of the camera (3), starting from the output signals of the scanning device, for the optimisation of the image of the object (6).

6. Monitoring apparatus in accordance with one of the claims 1 to 5, characterized in that the scanning device is a scanner (1), in particular a line scanner, a V-scanner or a surface scanner, which scans the predetermined monitored space with a pulsed laser using periodically sequential scanning procedures and which evaluates the reflected laser light by means of an optical detector device.

7. Monitoring apparatus in accordance with claim 6, characterized in that the scanner (1) determines the spatial position of the object (6)

in the monitored space by determination of the distance (d) between the scanner (1) and the object (6) and also by determination of the scanning angle (φ) of the object (6).

8. Monitoring apparatus in accordance with claim 7, characterized in that the distance (d) between the scanner (1) and the object (6) is determined by a transit time measurement of the laser light pulse, and in that the scanning angle (φ) is determined by an angle sensor.

9. Monitoring apparatus in accordance with one of the claims 1 to 8, characterized in that there are provided a storage device, in which at least two sets of data for scanning procedures can be stored, and a comparison device which compares the data sets in the storage device with one another and, on finding a deviation between these data sets, detects the appearance of an object (6) and transmits output signals to the camera control (2) which reproduce the position of the object (6) in the monitored space.

10. Monitoring apparatus in accordance with claim 9, characterized in that the storage device contains a data set for a reference scan of the monitored space without an appearing object (6), and in that the comparison device compares the data set for each new scan with the data set of the reference scan.

11. Monitoring apparatus in accordance with one of the claims 1 to 10, characterized in that the camera(s) is (are) switched on on the appearance of the object(s).

12. Monitoring apparatus substantially as herein described and as illustrated in Fig. 1.

13. Monitoring apparatus substantially as herein described and as illustrated in Fig. 2.